Chapter 12

Data Reduction and Audit Procedures

Chapter 12
Data Reduction and Audit Procedures
Table of Contents

Page

1.0 Introduction

The criteria listed within this chapter are designed to provide the State of Indiana, the National Aerometric Data Bank (NADB), and other consumers of air monitoring data with accurate pollutant and meteorological monitoring data. Data must be reduced in a consistent and regimented manner to ensure a measurement of statistical assurance that data are correct. Data audits are a means to achieve this statistical assurance.

2.0 Data Reduction from Strip Charts

For those entities which utilize a strip chart through a strip chart recorder or DAS recorder (e.g. ESC computers), it is very important that the data obtained from the strip chart is accurate. In addition, some agreement between the strip chart and the Data Acquisition System (DAS) numeric values needs to exist. Ideally, the strip chart should agree with the DAS by ± 2%. To obtain hourly averages from a strip chart, the procedures in Sections 2.1 and 2.2 should be employed.

2.1 Pollutant

1. Ensure the strip chart has at least a zero trace at the beginning and end of every one-week sampling period. Do not confuse the recorder offset or recorder electronic zero with the value of pollutant-free air sampled for a zero baseline trace response. These zero checks need to be documented on the chart along with the initials of the person performing the check, the name of the site, the chart speed, the date, the start and end time of the zero check, and the parameter. These weekly checks are only recommendations and not requirements; however, weekly zero air checks will provide site operators with more information for the data reduction. For those who utilize a DAS recorder, documentation should be made however possible.

2. Determine the hourly average for the interval of interest by recording the average percent of chart deflection for the hour. Next, subtract the zero and chart offset, and then multiply by the most recent monitor calibration relationship. For example, if a chart average is 26%, the zero is 1%, and the chart offset is 5% (note: the zero and chart offset are reflected as one trace on the chart; they are not two individual traces), and the range is .5 ppm for 100% of chart, then:

$$\textit{Hourly Average Concentration} = (26\% - 6\%)\ x\ \frac{.5\ ppm}{100\%} = .100\ ppm$$

3. For the data reduction, use that days' zero if the value is from the first 12 hours of the day. If the value is from the last 12 hours of the day use the next days' zero. If a weekly zero is used, use the closest zero or try to determine when the analyzer's zero shifted and then use that zero. In a lot of cases, the biweekly audit zero is used to determine hourly averages.

2.2 Meteorological

1. If applicable, check to see if the zero trace is at the correct offset. For example, a wind speed zero trace must be at zero percent chart (assuming no offset). If the zero response for the chart is not correct, values must be corrected for the drift.

2. Determine the hourly averages for the interval of interest and record the percentage of chart deflection. Subtract out any zero drift, if needed.

3. Convert the percent chart values to the appropriate meteorological value. For example, a wind direction chart value of 10 percent would correspond to 54 degrees if 100 percent of chart corresponds to 540 degrees.

3.0 Strip Chart Recorder Audit and DAS Trace Audit

The strip chart recorder should be evaluated to detect signs of monitoring system malfunctions which result in non-representative traces on the chart. Some DAS (e.g. ESC computers) will create a trace from the analyzer responses. This can also be looked at for irregular responses. Typical indications of malfunctions include:

1. A straight line trace (other than minimum detectable) for several hours

2. A wide, solid trace indicating excessive noise or erratic behavior, such as spiking

3. A long steady increase or decrease in deflection

4. A cyclic trace pattern with a defined time period

5. A trace below the zero baseline

6. A span drift 25% of span value

7. Excessive zero or span drift (see Chapter 11 of this manual)

The data for any time interval in which a malfunction of the sampling system is detected should be voided. Strip chart recorders must be calibrated annually (see Chapter 6 of this manual). The calibration frequency of the DAS will depend on the manufacturer; however, the OAQ Quality Assurance Section recommends an annual calibration. This will help eliminate some problems associated with the strip chart and DAS data.

4.0 Data Audits

In order to guarantee uniformity in application and procedure, all data collected must be audited prior to being used by an agency for any purpose. The term "agency" shall include: State agencies, municipal/county agencies, industrial entities/companies, consultants, and other

agencies as may be determined by the Chief, Quality Assurance Section (QAS), Office of Air Quality (OAQ), Indiana Department of Environmental Management (IDEM).

All data audits must be conducted by personnel not involved in either the data reduction process or data submittal. The responsibility of conducting the data audits shall be assigned to the QA staff of the agency whenever possible.

Affected agencies shall perform all required activities pertaining to data audits in accordance with the procedures set forth in this chapter. Failure to comply with required procedures can result in the invalidation of affected data until such time that compliance with required procedures has been established.

All affected agencies shall:

1. Audit all data for both completeness and correctness. Data is complete if you have 75% of the hour (50% for zero/span hours), the month, quarter, and year valid. Those sites designated as Prevention of Significant Deterioration (PSD) are required to have 80% instead of 75%. In addition, data is screened for correctness by following written standard operating procedures.

2. Maintain records of all data audits for at least three (3) years.

3. Document all missing or invalid data. Those hours which do not have a valid value must have a null value reason code.

4. Provide the Section Chief, QAS, OAQ, IDEM, a listing of all corrections to the Air Quality System (AQS) database. The corrections should be sent within forty-five (45) days after sending the actual data to the State.

5. Make available, upon request, access to or copies of all records and documentation pertaining to activities required by this chapter.

6. Audit all data prior to its use.

7. Provide training for all personnel involved with data audits required by this chapter. All training sessions provided by the IDEM, OAQ, QAS, shall be attended by all personnel affected. If, due to monetary or other limitations of the agency, or if attendance at the training session is not possible, the State will attempt to provide training at the agency.

5.0 Data Audit Procedures

The procedures specified in this chapter are general in nature and should be used when auditing data which will be submitted to the AQS Data Bank. The State QAS is currently in the process of utilizing an ESC DAS to perform the data audit checks. This process may be found in a State

QAS Standard Operating Procedure, 8-13. Alternate procedures for auditing data must be approved by the Chief of the QAS, OAQ, IDEM.

5.1 Intermittent Pollutant Sampling Data Audits

All intermittent sampling data shall be audited before submittal into the AQS Data Bank by the QA staff of the originating agency. The audit process shall incorporate standard operating procedures which are approved by the Chief, QAS, OAQ, IDEM. After submittal, the AQS data is reviewed by the State Ambient Monitoring Section (AMS). The data shall be audited by a QAS staff person at the minimum rate of seven (7) values per one hundred (100) values; however, at least one (1) value per month shall be audited. The values may be audited at the time of the post sampling QA filter audit check (see Chapter 7 of this manual). The following procedure is to be used:

1. The reported value (RV) found in the AQS printout is compared to the audit value (AV) found in the original analytical laboratory logbook and the percent difference is calculated.

2. The percent difference is calculated in the following manner.

$$Percent\ Difference = \frac{(RV - AV)}{AV} \times 100\%$$

3. If the percent difference is greater than plus or minus two percent (±2.0%), then the RV shall be changed to the AV and all other data values for the month shall be audited.

4. If the percent difference is less than plus or minus two percent (±2.0%), then no corrections need to be made and no additional values need to be audited.

5.2 Continuous Sampling Data Audits

All continuous sampling data, including meteorological parameters, shall be audited before submittal into the AQS Data Bank by the QA staff of the originating agency. The audit process shall incorporate standard operating procedures which are approved by the Chief, QAS, OAQ, IDEM. After submittal, the AQS Data is reviewed by the State AMS. The standard operating procedures for the QAS staff person shall include but not be limited to the following steps:

1. Use a standard data check sheet (see Form 1).

2. Complete the top portion of Form 1: site, AQS number, date that the data is from, and the parameter.

3. Look for any memos which correspond to the data being audited. A logbook containing the memos or information from any memos is acceptable. The information on the memo or in the logbook will identify any invalid periods, correction factors, or any other pertinent information.

4. If the parameter being audited has a daily zero or span data, then the percent drift must be checked. Span drift must be no more than 5% from one span to the next. Zero drift must not be more than 2% (4% for 0.5 ppm SO_2 range). An explanation as to why the drift occurred must be documented.

5. Examine the chart trace to determine unusual or strange responses during the time that the data was collected. Items to look for include spiking of the analyzer, a straight line for wind direction, responses below zero baseline, etc. Experience of the auditor and monitor specific characteristics will help determine other items to consider. In addition, calibrations, audits, null codes, etc. should be verified while looking at the chart.

6. Verify null codes by checking the chart trace and by looking for any memos stating that a problem had occurred.

7. When applicable, verify that the correct zero has been subtracted out for each data value.

8. Verify all high values. Table 1 lists the parameter and the criteria (or limit) for checking high values. For meteorological parameters, see Section 5.3.

Table 1
High Values to be Verified

Parameter	Values to check
SO_2	Hourly average ≥ .100 ppm
NO_2	Hourly average ≥ .100 ppm
O_3	Hourly average ≥ .100 ppm and any 8 hour average ≥ .085 ppm
CO	Hourly average ≥ 9 ppm
PM_{10} (Continuous)	Daily average ≥ 100 μg/m^3
$PM_{2.5}$ (Continuous)	Daily average ≥ 50 μg/m^3

9. For any manually reduced data (data not reduced by a computer or data logger), check 2 hours for every 24 hour day. The value being reported and the auditor's value must agree within 2% of the range of the analyzer. If an error is found, review the 12 hours preceding and following where the correction was made.

10. Review all exceedances. A separate logbook should be maintained with all paperwork showing that the exceedance was reviewed (see Section 6.0).

11. The indoor shelter temperature for the site must be checked. If the site temperature is not in the range of 15.0 to 33.0 degrees Celsius, then the data is invalid (this does not include meteorological parameters or PM_{10}/$PM_{2.5}$ continuous monitoring).

12. For meteorological parameters, follow the guidelines listed in Section 5.3 of this chapter.

13. The monthly data sheet must be initialed by the AMS staff person who reduced the data.

14. The auditor must initiate corrective action(s) for all unsatisfactory items indicated on Form 1. Corrective action usually entails informing the parameter (network) operator of the problem(s) and then conducting a follow-up audit to ensure the correction was made.

15. A comments section should be included.

16. The data check report must be documented with the date that it was quality assured, initialed by the QAS staff person, and state the status of the data (e.g., okay, corrections needed).

Items 1 through 16 are intended as general guidelines, and they do not encompass all possibilities. A lot of the information will rely on computer logs, strip chart documentation, and calibration/audit reports. Other checks should include making sure that there is not more than a ± 2.0% difference between the DAS reported values and the manual data values. The manual data source and electronic data acquisition system should be checked against each other and against a certified multimeter during calibrations and audits. Also, when an exceedance of the National Ambient Air Quality Standards (NAAQS) primary and secondary standard has occurred, it will need to be verified and recorded (see Form 2).

5.3 Meteorological Data Audit Criteria

Listed below are audit criteria for the meteorological parameters. Meteorological data falling under these conditions should be evaluated. The criteria listed are intended as general guidelines and do not encompass all possibilities. Additional criteria may be obtained from federal guidelines such as EPA-454/R-99-005 Table 8-4, and equipment manufacturers.

A. Wind Speed

1. Calms are defined as zero wind speed and zero wind direction.

2. Any value less than zero or greater than 20 m/s (45mph)

3. Values which are unchanged for any three (3) consecutive hours with the exception of calm hours

4. A change of ± 5 m/s (10 mph) from one hour to the next consecutive hour

5. Any non-zero value less than the instrument's threshold limit

6. Any non-zero value which occurs during a corresponding zero wind direction

7. Any zero value which occurs during a corresponding non-zero wind direction

8. First five (5) hourly values ± 0.2 mph of the next four

B. Wind Direction

1. Calms are defined as zero wind speed and zero wind direction.

2. Any value less than zero or greater than 360^{o}

3. Values which remain unchanged for any three (3) hours

4. Any non-zero value which occurs during a corresponding non-zero wind speed

5. Any zero value which occurs during a corresponding non-zero wind speed

6. Any value for which the wind speed is less than the response threshold of the instrument

7. Value(s) which remain in the same sector (a sector is defined as any 90^{o} portion of the 360^{o} possible for wind direction) for more than 18 consecutive hours

8. First five (5) hourly values within 2^{o} of next four (4) hourly values

C. Outdoor Temperature

1. Any value greater than 45^{o}C (113^{o}F) or less than -30^{o}C (-22^{o}F)

2. Values which are unchanged for any five (5) consecutive hours

3. A change of ± 5^{o}C (9^{o}F) from one hour to the next consecutive hour or change of 10^{o}C (18^{o}F)

4. Visually scan for negative values

D. Outdoor Temperature Difference

1. Any change in value which is greater than 0.1^{o}C/minute during daytime hours

2. Any change in value which is less than -0.1^{o}C/minute during nighttime hours

3. Any change in value which is greater than 0.5^{o}C or less than -3.0^{o}C

E. Dew Point

1. Dew point changes greater than 7^{o} F in one (1) hour

2. First five (5) values within ±0.5°C of next four (4)

3. Dew point temperatures greater than 32.2°C (90°F)

4. Dew point temperatures less than -51.1°C (-60°F)

5. Dew point(s) which equal temperature(s) for more than twelve (12) consecutive hours

6. Dew point values equal to or greater than the temperature values for a given hour

F. Radiation

1. Radiation value(s) should be zero during nighttime/dark hours.

2. Radiation value(s) should not exceed the range of the instrument.

G. Atmospheric Pressure

In order to accurately observe guidelines for pressure data auditing, limit values for specific site locations must be calculated and applied properly.

1. Value(s) greater than 1060 mb (corrected to Sea Level)

2. Value(s) less than 940 mb (corrected to Sea Level)

3. Values which change more than 6 mb or 0.1 inches Hg within three (3) consecutive hours

H. Precipitation

1. Any value(s) greater than 25 mm in one hour

2. Any value(s) greater than 100 mm in 24 hours

3. Any value(s) less than 50 mm in three (3) months

The criteria above should be adjusted according to local climatic conditions.

6.0 Documentation of Audits

All data audits and NAAQS exceedances shall be documented on standard forms used by the agency. The forms may be either in loose-leaf or bound format and shall be kept for at least three (3) years. All data audit and exceedance forms shall contain at least the following information (see Forms 1, 2, and 3):

1. Agency
2. Site location or name (Do not use an agency derived identification number, e.g. Site 9)
3. Site AQS number
4. Parameter
5. Year audited
6. Month(s) audited
7. Date(s) audited
8. Auditor initials
9. Comments

In addition to the minimum information required, all exceedance verification forms shall include the hour(s) audited. Any invalid or missing data may be documented in the comments portion of data audit forms.

7.0 Corrections to Data

When corrections to the AQS data are made, the agency shall inform the Chief, QAS, OAQ, IDEM, of all corrections within forty-five (45) days of receipt of the quarterly AQS printout. All corrections shall be reported on a standard approved form that includes at least the following information (see Form 3):

1. Agency
2. Site location or name (Do not use an agency-derived site number, e.g., Site 9)
3. Site AQS number
4. Parameter
5. Year
6. Month
7. Date corrected
8. Hour corrected
9. Value to be corrected (as printed in AQS)

10. Correct value

11. Comments

If any data to be used for purposes other than inclusion in AQS is identified as incorrect, it shall be corrected prior to the use of that data. Any corrections shall be recorded on an approved form. A sample form for recording data corrections is shown on Form 3.

8.0 Inspection of Records

All reporting groups shall upon request, make available to the IDEM, OAQ, QAS, and their representatives, all records pertaining to items required by this chapter. Failure to provide the information shall result in the invalidation of the subject data until the request is fulfilled.

Form 1
Indiana Department of Environmental Management
Office of Air Quality Continuous Data Check Form

Site: _____ **Date:** _____

AQS #: _____ **Parameter:** _____

			Correction/Comments
1. Invalid Data Memos	S	U	NA
2. Daily Span Drift (± 5%)	S	U	NA
3. Daily Zero Drift (± 2%) (± 4% on .5 SO_2)	S	U	NA
4. Chart Trace	S	U	NA
5. Null Codes	S	U	NA
6. Correct Zero Subtracted Out	S	U	NA
7. High Values Verified (≥ .100 ppm SO_2, NO_2; ≥ 9 ppm CO) (≥ .100 ppm and 8 hour average ≥ .085 ppm O_3) (≥ 100 μ/m^3 PM_{10}, > 50 μ/m^3 $PM_{2.5}$)	S	U	NA
8. Hand Reduced Data Valid (within ±2%)	S	U	NA
9. Exceedances Reviewed	S	U	NA
10. Shelter Temperature (59 to 91.4 ^oF)	S	U	NA
11. Meteorological Criteria	S	U	NA
12. Data Check Initialed	S	U	NA

Initials: _____

S=Satisfactory, agrees with Quality Assurance values/findings
U=Unsatisfactory, does not agree with Quality Assurance values/findings
NA=Does not apply to this data check

Comments:

_____
_____
_____

Data Check Completed Date: _____
Data Check Performed By: _____

Form 2
Indiana Department of Environmental Management
Office of Air Quality Exceedance Check Form

Site: _____ **AQS #:** _____

Parameter: _____ **Auditor:** _____

Date	Time	Reported Value

Information regarding copy of attached audit or calibration prior to listed exceedance(s)

Date of audit or calibration_____ Calibrator Certification Date_____
Certification calculations are correct and output is consistent_____
Audit settings and calculations are correct_____
Comments or additional
information_____

Is a special audit necessary_____

If so, what date_____Time_____Auditor_____
What data should be picked up_____

Information regarding copy of attached audit or calibration after listed exceedance(s)

Date of audit or calibration_____ Calibrator Certification Date_____
Certification calculations are correct and output is consistent_____
Audit settings and calculations are correct_____
Comments or additional information _____

Form 3
Indiana Department of Environmental Management
Office of Air Quality AQS Corrections

Site: _____ **Parameter:** _____

AQS #: _____ **Operational Period:** _____

Month	Day	Hour	Reported Value	Correction	Comments

Date Completed: _____